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Does intolerance of uncertainty predict anticipatory startle responses to uncertain threat?

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ABSTRACT

Intolerance of uncertainty (IU) has been proposed to be an important maintaining factor in several anxiety disorders, including generalized anxiety disorder, obsessive–compulsive disorder, and social phobia. While IU has been shown to predict subjective ratings and decision-making during uncertain/ambiguous situations, few studies have examined whether IU also predicts emotional responding to uncertain threat. The present study examined whether IU predicted aversive responding (startle and subjective ratings) during the anticipation of temporally uncertain shocks. Sixty-nine participants completed three experimental conditions during which they received: no shocks, temporally certain/predictable shocks, and temporally uncertain shocks. Results indicated that IU was *negatively* associated with startle during the uncertain threat condition in that those with higher IU had a smaller startle response. IU was also only related to startle during the uncertain (and not the certain/predictable) threat condition, suggesting that it was not predictive of general aversive responding, but specific to responses to uncertain aversiveness. Perceived control over anxiety-related events mediated the relation between IU and startle to uncertain threat, such that high IU led to *lowered* perceived control, which in turn led to a smaller startle response. We discuss several potential explanations for these findings, including the inhibitory qualities of IU. Overall, our results suggest that IU is associated with attenuated aversive responding to uncertain threat.

1. Introduction

Intolerance of uncertainty (IU) has been defined as the tendency to respond with negative emotional, cognitive, and behavioral reactions to uncertain situations and events (Dugas et al., 2004). Those who are intolerant of uncertainty report finding ambiguous situations stressful (particularly those in which a negative outcome is possible) and report having difficulty functioning under such circumstances. Individual differences in IU have been proposed to be a causal risk factor for worrying (Dugas et al., 2004), which subsequently can lead to the development and maintenance of several anxiety disorders, including generalized anxiety disorder (GAD; Dugas et al., 1998; Dugas and Ladouceur, 2000; Ladouceur et al., 1999), obsessive–compulsive disorder (OCD; Holaway et al., 2006; Tolin et al., 2003) and social anxiety (Boelen and Reijntjes, 2009). Therapeutic interventions aimed at increasing tolerance to uncertainty have also been shown to reduce worry, with changes in IU generally preceding changes in worry (Dugas and Ladouceur, 2000; Ladouceur et al., 2000a). These along with other studies (e.g., Ladouceur et al., 2000b) suggest a causal role between IU and pathological anxiety.

In numerous laboratory studies, individual differences in IU have been associated with subjective ratings and decision-making about uncertain and ambiguous situations. For example, individual differences in IU have been shown to predict negative appraisals of ambiguous situations (Koerner and Dugas, 2008), perceptions of threat (Bredemeier and Berenbaum, 2008; de Bruin et al., 2006), and the amount of information required to make a decision during an ambiguous situation (Ladouceur et al., 1997). Other studies have examined the relation between IU and emotional state (using physiological measures) during uncertain situations; however, these results are somewhat mixed. For example, Greco and Roger (2001) found that high IU was associated with a *smaller* change in blood pressure and heart rate while engaging in a stress-inducing task. However, in a subsequent study, Greco and Roger (2003) found that compared to low IU individuals, high IU individuals exhibited increased blood pressure while anticipating unpleasant pictures; though, this finding was for both predictable and uncertain unpleasant pictures (suggesting a general sensitivity to aversiveness, and not just uncertain aversiveness). These findings indicate that the relation between IU and emotional state during uncertain situations remains unclear.

The startle reflex is another psychophysiological tool that can be used for measuring emotional states during uncertain situations.

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Startle is a cross-species response to an abrupt intense stimulus, and is a well-documented indicator of defensive system activation (Lang, 1995). Startle is a particularly advantageous measurement in this context as it provides an online assessment of emotional states. Most importantly, unlike other psychophysiological measures (e.g., skin conductance) it has been shown to be sensitive to the valence of the emotion (Lang et al., 1993). Specifically, startle is potentiated (increased) during aversive emotional states, such as anxiety (Lang et al., 1998), and attenuated during positive emotional states (Giargiari et al., 2005; Lang et al., 1990). The neurobiology of startle has also been studied extensively (Koch, 1999). Basic research in animals has indicated that startle reflex to predictable and uncertain threat are mediated by overlapping but distinct neural systems, specifically the central nucleus of the amygdala for predictable threat, and the bed nucleus of the stria terminalis for uncertain threat (Davis, 2006; Gray and McNaughton, 2000).

Of particular relevance to the present study, startle has also been examined during situations in which the timing of aversive stimuli was uncertain. Grillon and colleagues developed a task where startle was measured while participants anticipated an aversive stimulus (e.g., shock) that was temporally predictable or uncertain (Grillon et al., 2004, 2006, 2008). Using this task, Grillon and colleagues found that, compared to healthy controls, individuals with particular anxiety disorders (i.e., panic disorder [PD] and posttraumatic stress disorder [PTSD]) exhibited abnormally elevated startle when the aversive stimuli were temporally uncertain, but not when the aversive stimuli were predictable (Grillon et al., 2008, 2009). This suggests that these anxiety disorders are associated with a hyper-responsiveness to uncertain threatening situations, but normal responsiveness to predictable threatening situations.

In the present study, we examined the association between individual differences in IU and startle to uncertain threat using Grillon and colleagues' paradigm. We hypothesized that there would be an association between individual differences in IU and startle to uncertain threat. However, it was somewhat unclear whether the predicted direction of this association would be positive or negative. In many conceptualizations of IU, individuals who are intolerant of uncertainty exhibit an elevated negative response (self-report and behavior) during uncertain situations (although no studies have specifically examined this association using the startle reflex). Therefore, one possibility is that individuals who are highly intolerant of uncertainty will exhibit *greater* startle potentiation while anticipating uncertain threat, similar to the aforementioned findings for PD and PTSD (Grillon et al., 2008, 2009).

However, IU has been shown to have differential associations with various anxiety disorders — with stronger associations with measures of GAD (Dugas et al., 1998; Dugas and Ladouceur, 2000; Ladouceur et al., 1999) than with measures of PD (Dugas et al., 2001). This suggests that IU may not demonstrate the same pattern of association with startle responding to uncertain threat that has been shown with PD and PTSD. Moreover, studies have suggested that the 'psychophysiological profile' for GAD is different than that of other anxiety disorders (e.g., Hoehn-Saric et al., 1989; Lyonfields et al., 1995; Thayer et al., 1996).

An alternative possibility is that IU may be associated with *smaller* startle potentiation while anticipating uncertain threat, as IU may inhibit aversive responding similar to other measures of physiological responding that have been observed in GAD. For example, Hoehn-Saric et al. (1989) found that patients with GAD showed a weaker skin conductance response (a physiological index of arousal) relative to controls during a psychological stress task. Lyonfields et al. (1995) and Thayer et al. (1996) also found that GAD was associated with reduced autonomic flexibility due to lower cardiac vagal tone, suggesting impaired parasympathetic activity. In terms of startle studies, Lang, McTeague, and Cuthbert (2007) found that, relative to other anxiety disorders, GAD was associated with the weakest fear-potentiated startle response during a fear-imagery task, and also appeared attenuated compared to controls (although they never directly compare GAD participants to controls). In addition, a recent review on startle responding in anxiety disorders found that the literature on startle responding in GAD has yielded more inconsistent results than most other anxiety disorders (Vaidyanathan et al., 2009).

Therefore, the hypothesized direction of an association between IU and aversive responding may depend on the *type* of emotional/behavioral response that high IU individuals exhibit when they are confronted with an uncertain situation. Put simply, if intolerance leads to a negative arousing response, one would predict a positive correlation between IU and aversive responding. If intolerance leads to an inhibitory response, one would predict a negative correlation between IU and aversive responding. Several factor analytic studies of measures of IU have found separable (though correlated) dimensions for IU mapping onto these facets — one labeled prospective anxiety and the other inhibitory anxiety (Carleton et al., 2007; McEvoy and Mahoney, 2011). Thus, as a secondary aim of the study we will examine which subscales of IU appear to be driving the overall IU-aversive responding association.

Depending on the direction of the results, there are several potential mechanisms that could explain the hypothesized results. In the present study, we will specifically examine one mechanism — perceived controllability. Animal studies have long shown that the controllability of aversive stimuli predicts affective, cognitive, and physiological reactions to the stimuli (e.g., Glass and Singer, 1972; Weiss, 1971). Controllability also overlaps significantly with predictability, as controllable events are also, in turn, predictable (Mineka and Kihlstrom, 1978). Given the relation between predictability and controllability, one possibility is that IU may lead to changes in the perception about controllability over aversive events. To test this, we administered the Anxiety Control Questionnaire (ACQ; Rapee et al., 1996), a measure specifically designed to assess individual differences in perceived control over anxiety-related events. Similar to IU, research has indicated that a lack of perceived control can lead to negative subjective, behavioral, and physiological responding (Feldner and Hekmat, 2001; Sanderson et al., 1989; Zvolensky et al., 2001). In addition, perceived control over anxiety-related events is a proposed mediator of emotional/motivational tendencies and aversive responding (Barlow, 1988; Rapee et al., 1996). Therefore, as a third aim, we will examine whether perceived control over anxiety-related events mediates the relationship between IU and response to uncertain threat. We are specifically hypothesizing perceived control as the mediator and IU as the independent variable (and not the other way around) because aversive stimuli that are temporally uncertain are also, by nature, uncontrollable, but the opposite is not necessarily true (i.e., events that are uncontrollable may or may not be unpredictable; Mineka and Kihlstrom, 1978).

2. Material and methods

2.1. Participants

Sixty-nine ($N = 69$) introductory psychology students participated for course credit. Participants were excluded from the study if they reported any loss of hearing (including the startle probes in the baseline/habituation task [see below]), were visibly intoxicated, or were unable to read or write in English. Participant demographics are presented in Table 1. Participants in the present sample reflected the population of introductory psychology students at our institution and were predominately female and ethnically diverse. Informed consent was obtained prior to participation and the protocol was approved by the local Institutional Review Board.